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A QUASI-EXPERIMENTAL STUDY OF THE EFFECTS OF AN INTENSIVE COMPUTER PROGRAMMING EXPERIENCE ON THE SELF-ESTEEM AND LOCUS OF CONTROL OF A GROUP OF HIGH ACHIEVING INNER CITY YOUTHS

The American University PH.D. 1984

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by

Bradford Norman

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Frank Turaj

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ABSTRACT

The primary hypothesis was that an 120 hour Atari-designed programming experience would significantly enhance the self-esteem and locus of control of a group of students and that any improvement would hold up over an eight month period. The treatment group was 21 ninth and tenth grade students, all of black racial origin, from a selective, public, college-preparatory high school in the District of Columbia. No student in the treatment group had any prior computer experience. The independent variable consisted of a computer programming experience designed by Atari for use at their summer computer camps and was held in the Future Center of the Capital Children's Museum for a month during the summer. The students were introduced to computer graphics, computer sound generation, and text processing during the first three weeks and were encouraged to design an independent project during the fourth.

Self-esteem was measured by Coopersmith's *Self-Esteem Inventory*, and locus of control by Crandall, Katkovsky, and Crandall's *Intellectual Achievement Responsibility* questionaire. The instruments were administered to the treatment group before and after the treatment and again eight months later. The third administration was given to the treatment group and a comparison group drawn from classmates of the treatment group.

Self-esteem mean scores increased significantly between the pretest and postest and regressed slightly on the follow-up test given eight months later. However, the mean difference between the pretest and the follow-up remained significant.

Locus of control mean scores increased significantly between the pretest and postest, and made a non-significant gain between the postest and the follow-up. The mean difference between the pretest and the follow-up for locus of control was significant. No significant difference was found between the treatment and the comparison group for either locus of control or self-esteem. All results are reported at a $p < .05$ level of significance or better.

The findings suggest that self-esteem and locus of control can be enhanced by a computer programming experience and that the gain can be more than a short-term shift.

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TABLE OF CONTENTS

ABSTRACT. ii

ACKNOWLEDGEMENTS. iv

LIST OF TABLES. viii

Chapter

I. THE PROBLEM AND ITS SETTING. 1

Introduction. 1

Statement of the problem. 3

Rationale for the hypotheses. 4

Hypotheses. 6

Definitions 7

Assumptions 10

Delimitations 10

Importance of the study 11

II. REVIEW OF THE LITERATURE 13

Perspective Principle 15

Autotelic Principle 18

Productive Principle. 23

Personalization Principle 25

III. METHODOLOGY. 28

Research design 28

Subjects. 29

Instruments 29

Independent variable. 34

Procedure 37

Data collection and analysis. 38

Ethical considerations. 40

IV. RESULTS AND DISCUSSION 42

Results 43

Discussion. 50

V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS 58

Summary 58

Conclusions 62

Recommendations 63

REFERENCES. 66

LIST OF TABLES

1. Mean Differences for the Treatment Group Between Pretest and Postest on Locus of Control. 43
2. Mean Differences for the Treatment Group Between Pretest and Postest on Self-Esteem 44
3. Mean Differences for the Treatment Group Between Postest and Follow-Up on Locus of Control. . . . . 45 Using a Two-Tailed Test of Significance
4. Mean Differences for the Treatment Group Between Pretest and Follow-Up on Locus of control. 46
5. Mean Differences for the Treatment Group Between Postest and Follow-Up on Self-Esteem Using a Two-Tailed Test of Significance. 47
6. Mean Differences for the Treatment Group Between Pretest and Follow-Up on Self-Esteem 47
7. Mean Differences Between Treatment and Comparison Groups on the Final Observation for Locus of Control 48
8. Mean Differences Between Treatment and Comparison Group on the Final Observation for Self-Esteem . . 49
9. Pretest Scores on Locus of Control for the Treatment Group from the Present Study by Sex. 51
10. Locus of Control (IAR) 1965 Normative Data for a Tenth Grade Sample by Sex with I+ and I- Means . . 52
11. Self-Esteem Data from Coopersmith's (1967) Study, Strodtbeck's (1972) Study, and Pretest Data from the Present Study by Sex. 55

CHAPTER I

THE PROBLEM AND ITS SETTING

Introduction

In 1968, Leonard wrote a prophetic book, Education and Ecstasy, in which he portrayed an educational marriage between humanism and technology. Papert (1981), in Mindstorms , wrote of educational microworlds where students can explore and learn about the culture of mathematics, much as a child learns the spoken language of his own culture. Malone (1980) wrote his doctoral dissertation on What Makes Things Fun to Learn?: A Study of Intrinsically Motivating Computer Games. Each of these authors has a vision of a self-paced, learner-centered, intrinsically-motivating learning environment. The first small steps toward this dream were taken in the 1950s and 1960s on large mainframe computers, but these were expensive and complicated. The dream was revived around 1975, with the invention of the microchip and the introduction of the personal computer.

Many concepts of how personal computers can be used in education are coming to the forefront. Taylor (1980) sees the computer acting in three modes. First, as a tutor, where it operates in a question and answer mode and can keep records of the student's responses. Computer Aided Instruction (CAI) and Computer Managed Instruction (CMI) are examples of this use. Second, as a tool, the computer will perform useful tasks such as statistical analysis, super calculation, or word processing. In the third mode, the computer is "taught" by the student or in Taylor's terminology, becomes the tutee. The computer is ideal in this role, because it is patient, logical, and reprogrammable. Problem solving and programming lead the learner to think about a problem in an organized, logical, and sequential manner. To paraphrase Papert, the learner is led to think about thinking.

Drawing on the theories of Piaget, Papert (1981) states that "what an individual can learn, and how he learns it, depends on what models he has available." This in turn leads to the question of how intellectual structures grow out of one another and about how, in the process, they acquire both logical and emotional form. The personal computer could be a powerful instrument for discovering new models and synthesizing new structures. For example, the computer's ability to simulate graphics, sound, and text allows the learner to explore in imaginative microworlds, and through this experience become the builder of new intellectual structures.

In addition to the interest that personal computers have generated in the cognitive domain, there is a growing interest in the effects of computer use on non-cognitive factors, such as locus of control and self-esteem. Coleman (1966) found locus of control explained more variance in school achievement than any other variable in his massive Equal Educational Opportunity Study:

> A pupil attitude factor, which appears to have a stronger relationship to achievement than do all the "school" factors together, is the extent to which an individual feels that he has some control over his own destiny....The responses...show that minority pupils except for Orientals, have far less conviction than whites that they can affect their own environment and future. (Coleman et. al., 1966, p.23)

Self-esteem also is a strong predictor of school achievement and is bi-directionally related with it, meaning that good self-esteem tends to lead to school achievement and that good school achievement enhances self-esteem. Locus of control and self-esteem both correlate positively with school achievement and any course of study or new technology that might have an effect on either of these variables would certainly be of great interest to the educational community.

Statement of the Problem

The purpose of this study was to assess the impact of computer programming on two non-cognitive factors - locus of control and self-esteem. The treatment was an Atari-designed computer programming experience that lasted for one month during the summer. The task was to program Atari 800 microcomputers in the graphics, sound, and text modes using the computer language Pilot. A review of the literature revealed that little is known about the effects of computer programming on self-esteem and locus of control of students.

Rationale for the Hypotheses

The literature of *human motivation* and *cognitive development* suggests that computer programming might enhance self-esteem and locus of control. For example, persons who take responsibility for their successes and failures, are said to have *internal* locus of control, whereas persons who do not take responsibility for their successes and failures are said to have *external* locus of control. Students who are high achievers tend to have a high level of internal locus of control and tend to be more in control of their lives in general.

The literature on Computer Aided Instruction (CAI) suggests that working on computers might increase locus of control. Working on a computer is felt to put a student more in control of his or her learning environment than when he or she is in a more traditional classroom setting. Crandall (1977) gives some possible reasons:

1. It gives the student total control.
2. It operates in a cause-and-effect mode.
3. It is direct.

4. It provides immediate feedback.

5. It gives specific, explicit directions (p. 19).

A few studies (Crandall, 1977, 1979; Smith, 1971; Warner, 1981) have looked at the effects of computer aided instruction on locus of control and self-esteem, but to date there seem to be no studies which have tried to assess the effects of computer programming on the self-esteem or locus of control of school age children.

Computer programming requires logical thinking, problem solving, sequential thinking, self-discipline, and the ability to analyze and correct one's mistakes. The way a student treats error messages or programs that just won't run could have an effect on locus of control. Learning how to correct errors in a program is one of the most valuable lessons to be learned from a CPE. In computer jargon this procedure is called "debugging". Learning to correct errors in the logic of a program is frustrating at first, but once mastered it gives a student a sense of power. Learning the skill of debugging should have a positive effect on locus of control, especially if it helps the student take more responsibility for correcting his errors.

Students with high self-esteem usually are high achievers in school, and are more willing to take risks. They also have a lower level of anxiety than do students with low self-esteem (Coopersmith, 1967; Purkey, 1970). Low self-esteem students take fewer risks in general for fear of failure even though they may test well for appitude. Working on computers is a private affair. No one has to see the work. This attribute might encourage students with low self-esteem to take more risks. O'Neil (1970) found that using computers for instruction lowered students' anxiety and lessened the number of mistakes they made.

The literature on intrinsic and extrinsic motivation suggests ways of looking at locus of control and self-esteem. Intrinsically motivated learning takes place when a student is being reinforced by self-praise and by the joy of learning for its own sake (Lepper and Greene & Nisbett, 1973; deCharmes, 1968). There is evidence that working on personal computers tends to create a high degree of intrinsic motivation (Malone, 1981) and an attitude of self-reliance and mastery over the learning environment.

Hypotheses

Hypothesis 1

The mean score on locus of control for the treatment group will be significantly higher on the second observation than on the first.

Hypothesis 2

The mean score on self-esteem for the treatment group will be significantly higher on the second observation than on the first.

Hypothesis 3

The mean score on locus of control for the treatment group will show no difference between the second and third observations.

Hypothesis 4

The mean score on self-esteem for the treatment group will show no difference between the second and third observations.

Hypothesis 5

On the third observation the mean scores for locus of control and self-esteem will be higher for the treatment group than for the comparison group.

Hypothesis 6

There will be a greater improvement in mean of the (I-) scores than in the mean of the (I+) scores between the first and second observations of the treatment group.

Hypothesis 7

There will be a significant correlation between the self-esteem recorded by self-report and that recorded by instructors.

Definitions

Observations

Observations refer to the administration of the self-esteem and locus of control instruments. The first observation was made just prior to the CPE treatment and entailed the administration of the Self-Esteem Inventory (SEI) and the Intellectual Achievement Responsibility (IAR) Questionnaire to the treatment group.

The second observation was made just after the CPE treatment and entailed the administration of the SEI and the IAR to the treatment group. In addition, at this time the staff instructors completed a Behavioral Academic Self-Esteem (BASE) rating scale on each student. The third observation was made eight months later on the treatment and comparison group.

Locus of Control

Rotter (1966) defines locus of control as follows:

> When a reinforcement is perceived by a subject as ... not being entirely contingent upon his action, then, in our culture, it is typically perceived as the result of luck, chance, fate, as under the control of powerful others, or as unpredictable because of the great complexity of the forces surrounding him. When the event is interpreted in this way by an individual, we have labled this a belief in _external control._ If the person perceives that the event is contingent upon his own behavior or his own relatively permanent characteristics, we have termed this a belief in _internal control._ (p. 1)

The _Intellectual Achievement Responsibility_ (IAR) questionaire was used to measure locus of control. The IAR is a modification of Rotter's I-E scale and was designed to be used with school age children by Crandall, Katkovsky & Crandall (1965). It measures locus of control from the perspective of how well a student takes responsibility for his successes and failures. The IAR provides two subscales and a total score. The I+ subscale measures the student's tendency to see himself as responsible for the positive reinforcements he receives in academic situations. The I- subscale measures his tendency to see himself as responsible for his negative reinforcements or failures in such situations, while the Total I score is the sum of the subscores, and measures the student's general acceptance of responsibility for outcomes of his achievement efforts. A high score on each of the scales represents internal responsibility, a low score, external responsibility.

Self-Esteem

Stanley Coopersmith (1981), whose Self-Esteem Inventory (SEI) was used in this study defines self-esteem as follows:

> The term "self-esteem" refers to the evaluation a person makes and customarily maintains with regard to him- or herself. "Self-esteem" expresses an attitude of approval or disapproval and indicates the extent to which a person believes him- or herself capable, significant, successful, and worthy. In short, a person's self-esteem is a judgement of worthiness that is expressed by the attitudes he or she holds toward the self. It is a subjective experience conveyed to others by verbal reports and other overt expressive behavior. (p. 5)

The SEI is a self-report questionnaire which appraises self-esteem relative to school, family, peer, self, and general social activities. In addition to measuring self-esteem by the SEI, it was also measured by the *Behavioral Academic Self-Esteem* (BASE) scale. The BASE emphasizes traits pertinent to self-esteem as reflected in effective academic performance. The BASE is scored by an instructor and includes five factors: (a) student initiative, (b) social attention, (c) success/failure, (d) social attraction, (e) self-confidence. The BASE was constructed using Coopersmith's theories and is designed to be used in conjunction with the SEI (Coopersmith & Gilberts, 1982).

Assumptions

Although self-esteem and locus of control tend to be very stable over time, remaining unchanged for years, a basic assumption of this study was that self-esteem and locus of control could be changed. An additional assumption was that the treatment would be sufficient to effect a change in a student's self-esteem and locus of control. It was also assumed that the instruments used to measure the dependent variables would behave in this study as they have behaved in previous studies. Another assumption was that the CPE would be an intrinsically motivating experience, and, finally, that the students would respond to the instruments in good faith.

Delimitations

The external validity of the results might be limited to reasonably intensive computer programming experiences which may not be replicable in classroom settings. The external validity of the results might also be limited to high achieving Black youths, because the subjects were all of black racial origin and were drawn from one of the city's top selective, public, college-preparatory high schools.

A major threat to internal validity was the inability to randomly select the subjects. The experimental group was chosen by the students' home school. Another threat to internal validity was the lack of a control group for the first two measurements of the dependent variables. A comparison group was constructed for the third measurement of the dependent variables by matching the experimental group with peers from their own class.

Importance of the Study

Many studies, done in the past five years, on the effects of using microcomputers in the schools have reported changes in students' behavior. In a multi-year three city study of microcomputer use in the schools Sheingold, (1983) found that:

> Teachers report primarily the social outcomes related to interaction, status, and self-esteem. That teachers in all sites made such comments clearly highlights this as a rich area for study. (p. 430)

What teachers are reporting is real but anecdotal. This study measured two of these social outcomes quasi-experimentally investigating whether 120 hours of intensive computer programming would enhance locus of control and self-esteem and whether any change saved hold up over eight months.

CHAPTER II

REVIEW OF RELATED LITERATURE

What is there in the literature to suggest that a computer programming experience (CPE) might enhance a student's locus of control or self-esteem? An argument will be built drawing on studies from cognitive psychology, computer-aided instruction, computer programming, and motivation theory, as well as from the background studies on locus of control and self-esteem.

A precursor to today's experimentation with microcomputers was O. K. Moore's work in the 1950s with the "talking typewriter". The device was designed to be a "clarifying educational environment" in which students would recieve verbal reinforcement designed to make the learning process more natural. For example, if the student typed the word "cat" the typewriter would say the word "cat" in response. The concept was to make the learning of the written word more natural and closer to the way children learn the spoken word; by trial and error with constructive feedback. The rationale is similar to the one Seymour Papert holds for his concept of educational microworlds. Both Moore and Papert's views are compatible with Jean

Piaget's theories of children as builders of new intellectual structures if they are provided with material that they can assimilate or accomodate into their existing intellectual structures.

Moore and Anderson (1969) defined a set of principles for creating what they call "clarifying environments". The concepts behind the principles draw on Moore's work with the talking typewriter as well as on the theories of Mead (1934, 1938). These four principles will be used as a framework to analyze what goes on in a computer programming experience that could have an effect on locus of control or self-esteem. Moore's four principles for a clarifying environment are as follows:

> 1. Perspective Principle. One environment is more conducive to learning than another if it both permits and facilitates the taking of more perspectives toward whatever is to be learned.
>
> 2. Autotelic Principle. One environment is more conducive to learning than another if the activities carried on within it are more autotelic. (Autotelic means self-goal or self-purpose).
>
> 3. Productive Principle. One environment is more conducive to learning than another if what is to be learned within it is more productive.
>
> 4. Personalization Principle. One environment is more conducive to learning than another if it: (1) is more responsive to the learner's activities, and (2) permits and facilitates the learner's taking a more reflexive view of himself as a learner. (p.585)

Perspective Principle

The perspectives that Moore and Anderson are talking about encompass four personality variables which they call: agent, patient, reciprocator, and referee. They derive them from Mead's concepts of personality and socialization of the self.

The _agent_ perspective is operating when a person is in control of and absorbed in an activity like a puzzle, for example. Moore and Anderson's agent perspective is very similar to Rotter's perception of how a person acts when his or her internal locus of control is high. The agent perspective is also similar to what deCharms means by a person being an "origin", for example, when one is originating and in control of one's actions.

The _patient_ perspective connotes being the recipient of consiquences over which one has no control or the way one feels when playing games totally dependent on chance. The patient perspective is similar to Rotter's perception of how a person acts when his or her external locus of control is high, and is also similar to what deCharms means by a person being a "pawn". Each designation describes a person who sees himself at the mercy of significant others or of luck.

The _reciprocal_ perspective stresses the ability to see another person not merely as a puzzling or unpredictable being, but rather as someone who is capable of seeing you as you see him, and it presumes an agent-patient perspective as would be experienced in games of strategy.

The referee perspective presupposes significant others in an interaction. For our purposes teachers, parents or other evaluators would be referees. Moore and Anderson assume that learning is more rapid and deeper when as many of the perspectives as possible can be engaged.

Malone (1980, p.6) commenting on the perspective principle suggests that arithmetic could be improved by letting students not only solve problems given to them by their teacher, but by their giving each other problems to solve. This kind of interaction between students is frequently seen when two students share the same computer terminal. The Atari-designed curriculum that was used had the perspective principle embedded in its design. For example, the initial exercise demonstrated the agent-patient perspective. The students were asked to place information about themselves on computer memory discs. In addition to demographics, they were asked to list their favorite type of music, movie, TV show, movie actor or actress. The information discs were then distributed and the task was to guess whose disc each student had. The computer continued to give the student clues until the person guessed whose disc he or she had. This exercise was a very effective way of building group cohesiveness. The students learned each other's name quickly and got to know the computer as a non-threatening tool.

Graphics was introduced from two perspectives. First, the students were introduced to Cartesian coordinate geometry where they learned to place what they wanted on the video screen by designating the coordinates on an imaginary grid. Second, they were introduced to Turtle Geometry, which is part of the Pilot computer language. Turtle Geometry introduces the concepts of angles, lengths, and rotation, and allows the students to create dynamic figures on the screen with a few powerful commands. Third, the programming of a song into a computer also drew on more than one perspective, because the student had to use standard musical notation in addition to computer sound generation code.

These learning situations call on more than one perspective and reflect real life situations using the power of the computer to produce exciting output. Such activities are likely to enhance self-esteem and locus of control, because the learning activities are under the student's control and their accomplishments sometimes seem miraculous because of the power of the computer. Papert, Watt, diSessa, and Weir (1979, sec. 1.17) in the final report of the Brookline LOGO Project stressed how many different viewpoints students brought to their problem solving and the diversity of intellectual styles they used. They also observed that acquiring the programming language LOGO had a salutory effect on a student's image of him or herself as a learner.

Autotelic Principle

The autotelic principle has important implications for computer learning situations. Its basic premise is that learning can be enjoyed for its own sake and that in the initial phases the learner should be protected from external criticism or reward. After a skill or knowledge has been thoroughly learned it is then appropriate to put it to the test or to serious competetion. However, the way to learn difficult things initially, according to the autotelic principle, is for the students to be placed in an environment in which they can try things out, make fools of themselves, and guess outrageously - all without serious consequences (p. 588).

The autoletic principle is very similar to the concept of intrinsic motivation. Neill (1960, p. 162) makes the comment that "to offer a prize for doing a deed is tantamount to declaring that the deed is not worth doing for its own sake." Mark Lepper and David Greene (1973) did a series of experiments that showed that the giving out of rewards by teachers can lead to a student's loss of interest in an activity. Covington and Beery (1976) say that paying a student for what he might otherwise have done freely can transform pleasure into drudgery. And, Lepper and Greene (1975) in a later study found that students who were observed by an adult during an initial play session with a puzzle showed a distinct disinterest in doing the puzzle in a later session if the adult were not present.

Csikzentmihayli (1975) instead of asking how intrinsic motivation affects learning asks what is intrinsically motivating? He describes a holistic sensation that people feel when they act with total involvement. He calls this sensation _flow_.

> In the flow state, action follows upon action according to an internal logic that seems to need no conscious intervention by the actor. He experiences it as a unified flowing from one moment to the next, in which he is in control of his actions, and in which there is little distinction between self and environment, between stimulus and response, or between past, present, and future. (p. 36)

Using factor analysis, Csikzentmihalyi ranked what composers, modern dancers, rock climbers, and chess players gave as reasons for enjoying an activity. The first three factors were: a) enjoyment of the experience and the use of skills, b) the activity itself: the pattern, the action, the world it provides, and c) development of personal skills (p.14).

Malone (1980) in his analysis of what makes things fun to learn isolates three variables: _challenge_, _curiosity_, and _fantasy_. Drawing on Piagetian theory he observes that "people are driven by a will to mastery (challenge) to seek optimally informative environments (curiosity) which they assimilate, in part, using schemas from other contexts (fantasy)" (p. 49). Although Malone's analysis was of computer games he remarks that computer programming is one of the best games of all.

Malone breaks his three major variables into smaller units that are valuable in explicating what make computer games intrinsically motivating.

1. Under _challenge_ he lists:
    a. Variable difficulty level
    b. Multiple level goals
    c. Hidden information
    d. Randomness
2. Under _fantasy_ he treats:
    a. Extrinsic fantasy
    b. Intrinsic fantasy
    c. Cognitive aspects of fantasy
    d. Emotional aspects of fantasy
3. Under _curiosity_ he treats:
    a. Sensory curiosity.
    b. Cognitive curiosity, encompassing completeness, consistency, and parsimony.

He makes two comments about challenge and curiosity which are relevent to learning computer programming.

> (1) Challenge requires an optimal level of difficulty in reaching a goal; curiosity requires an optimal level of complexity in what is to be learned. For this reason, both challenge and curiosity depend on adjusting the

> level of the environment to the level of the learner's ability and understanding.
>
> (2) Challenge involves reducing uncertainty about one's own ability to reach a goal; curiosity involves reducing uncertainty about the state of the world. Both depend on feedback to reduce uncertainty. (p. 60)

Malone goes on to say that he feels it is important to make a distinction between curiosity and challenge even though they closely parallel one another, and says that the notion of self-esteem is central to the idea of challenge, but that self-esteem is not involved in most instances of curiosity.

The graphics capability of the computer is a strong motivator. However, so much of what students are taught in school is presented in linguistic form by teachers who feel uncomfortable using models, lists, or graphs. Computer graphics can motivate students by drawing on the cognitive and emotional dimensions of fantasy. If a student is programming a space-ship to move up and off the screen, his choice of a space-ship says something about where he might be from an emotional fantasy standpoint. He could be ready to blast off from Cape Canaveral in his space-ship. The same programming experience could also have a cognitive fantasy component if the student is imagining himself as a structural engineer trying to make the rocket's fins the proper shape and size.

The dynamic nature of computer graphics can help make mathematical equations come to life on the screen instantaneously, or in slow motion. Music students can play a series of harmonic chords on a synthesizer and see the chords represented on the screen in standard musical notation. Chemistry students can call up a complex molecule and have its three-dimensional model on the screen in a matter of seconds. The model may then be rotated in any direction. The dynamic graphics capabilities of computers are awesome and give a person a sense of power, control, and competence in addition to a sense of being in touch with a body of knowledge that is larger than themselves. These can be powerful reinforcers of self-esteem and locus of control.

Text-processing can also be a powerful motivator. Children of all ages show extreme pleasure when they see their writing on the video-screen. The print is clear, the lines are straight, and the margins do not wobble. In essence, it looks good and makes the student feel good. Text-processing was the third component of the Atari CPE.

In summary, the autotelic principle can be satisfied very effectively by the use of microcomputers. The environment is both safe and private. The ability to simulate real world experiences by using the graphics, sound, and text capabilities of the computer can be motivating and draws on a student's sense of challenge, curiosity, and fantasy. When a student programs in such an environment he is in control of the outcomes, and as he learns to program effectively his sense of competence and accomplishment should increase and enhance his self-esteem and locus of control.

The Productive Principle

A productive learning environment must have a logical structure and be able to help a student make deductive inferences. For example, the periodic table of chemical elements does not list the elements in alphabetic order where little can be deduced, but lists them by their characteristics. Every element in the far right column has a full outer electron shell. A student of chemistry can deduce from this that these elements will not combine with any other element because they will neither accept, give away nor share an electron with another element. Students can also deduce from the periodic table of chemical elements the atomic weight and atomic number of each element.

The alphabet is more productive than the Chinese system of ideograms. The 26 phonetic letters may be combined in an almost infinite number of combinations and may be used by many different languages. The Chinese system, on the other hand, must deal with some 40,000 separate ideograms each of whose meaning is linked to an idea. Both the Chinese and the Japanese are working on simpler systems using sylabaries. The ultimate in productive codes, however, is the binary code used in computer programming. Unlike the 40,000 symbols used in classical Chinese, computer code has been reduced to two symbols. Productive marriages between computers and the alphabet have led to the creation of many specialized data bases. A computer can be used to search the collections of the Library of Congress, and within seconds produce a list of requested documents. It can be instructed to search the data base by title, author, or keyword. Combining and cross-referencing data sets makes computer searches even more productive.

The students in the Atari CPE did not have quite so exotic a system at their disposal, but they did have the chance to learn the basic principles of logical structuring which is the foundation of computer programming. One of the most valuable lessons to be learned from a CPE is how to break a problem down into its component parts and to then structure them into a logical sequence. A student's first experience with the Boolean logic of computers can be an exciting experience if it is presented in small enough increments and applied to problems of appropriate difficulty.

Arthur Luehrmann (1978), the co-inventor of the computer language Basic, sums it up nicely:

> I have observed that a student who is able to structure a problem for solution by computer nearly always has a better understanding of the problem than he or she got from purely verbal or purely mathematical description. (p. 139)

The Personalization Principle

Moore and Anderson state their final principle in two parts, the idea being that a learning environment must be both: (1) responsive to the learner's activities, and (2) helpful in letting him learn to take a reflexive view of himself.

Under the responsive condition they list:

> 1. It permits the learner to explore freely, thus giving him the chance to discover a problem.
>
> 2. It informs the learner immediately about the consequences of his actions.
>
> 3. It is self-pacing.
>
> 4. It permits the learner to make full use of his capacity for discovering relations of various kinds.
>
> 5. It is so structured that the learner is likely to make a series of interconnected discoveries about the physical, cultural or social world. (p. 602)

These five conditions are as valid when applied to computer programming ,today, as they were two decades ago when Moore and Anderson drew them up as the theoretical framework for their talking typewriter. Malone (1980) sees many of the same responsive attributes in computer programming.

> Programming itself is one of the best computer games of all. In the 'computer programming game', there are obvious goals and it is easy to generate more. The 'player' gets frequent performance feedback. The game can be played at many different difficulty levels, and there are many levels of goals available, both in terms of the finished product and in terms of the process of reaching it. Self-esteem is crucially involved in this game, and there are probably occasional emotional or fantasy aspects involved in controlling so completely,

> yet often so ineffectively, the behavior of this responsive entity. (p. 79)

The _reflexive condition_ is what Seymour Papert means when he talks about a learner learning about his own learning process. By discovering how he solves different problems the learner is better able to undertake whatever task comes next. Debugging a program, probably more than any other computer programming exercise, makes a student examine his own reasoning and the true nature of a program.

Flavell (1976) talks of this same process under the term _metacognition_ or its subset _metamemory_, which he defines as "one's knowledge concerning one's own cognitive processes and products or anything related to them." Piaget, Bruner, Gagne, and Papert in addition to Flavell have all emphasized the importance of metacognition. Flavell stresses the importance of a person being aware of when, and where to use procedures, and not just how. He also stresses the importance of knowing how and when to use external memory devices. The microcomputer is one of the most powerful and versatile of the many external memory devices that are available to students, especially when coupled to the extensive network of data bases that are available today. Books, videotapes, and audiotapes all qualify as external memory sources, but only the computer or another human being offer interactive responses. The complex structuring and analyzing of procedures that is called for in computer programming, in addition to knowing how to use existing programs and data bases should be a major metacognitive aid. In turn, the freedom of the metamind to observe and direct the mind might well put the student more in touch with the self in the learning process and more in touch with the amount of control he has over the process.

CHAPTER III

METHODOLOGY

Research Design

This study used a non-equivalent comparison group design with repeated measures on the treatment group, and with comparison to a non-equivalent reference group on the final or follow-up observation. The treatment group was measured for locus of control and self-esteem on three separate occasions: just prior to the treatment and just after the treatment one month later, and again eight months later during the school year. The dependent variables were locus of control and self-esteem. The independent variable was an Atari designed computer programming experience (CPE).

Self-esteem was measured by two instruments: a) the Self-Esteem Inventory (SEI), Coopersmith (1967), a self report instrument, and b) the Behavioral Academic Self-Esteem (BASE) scale, Coopersmith and Gilberts (1982), which is based on teacher observations. The BASE was administered only once, at the end of the treatment. Stanley Coopersmith the designer of the SEI and co-designer of the BASE with Ragnar Gilberts argues that self-esteem is best measured by using both self-report and observational methods.

Locus of control was measured three times using Crandall, Katkovsky, and Crandall's Intellectual Achievement Responsibility (IAR) questionnaire (Crandall et al., 1965). A comparison group was added for the final measurements. Both the treatment group and the comparison group were evaluated on self-esteem and locus of control at the same time: eight months into the school year. The comparison group was drawn from classmates of the treatment group with a major stipulation being that they not have more computer experience than the treatment group.

Subjects

The subjects, all of black racial origin, were 21 ninth and tenth grade students from a selective, public, college-preparatory high school in the District of Columbia. The Atari Corporation offered the CPE, including the software that they had developed for their nationwide summer camps, to the Capitol Children's Museum with the stipulation that all the students participating in the program be from District of Columbia schools. The subjects had no prior computer experience, and were chosen by the Assistant Principal of Banneker Junior High School.

Instruments

The Self-Esteem Inventory

The Self-Esteem Inventory (SEI) was developed by

Stanley Coopersmith in 1967 while he was working on a larger study of self-esteem in school age children. The SEI was adapted from the Rogers and Dymond (1954) scale by having a panel of five psychologists reword the statements so that they could be understood by children as young as eight. There are 58 questions on the school form of the SEI. Each question forces the student to answer either "Like Me" or "Unlike Me". The following are six sample questions from the SEI:

1. Kids usually follow my ideas.
2. I often feel upset at school.
3. I'm proud of my school work.
4. Most people are better liked than I am.
5. I like to be called in class.
6. My parents usually consider my feelings.

After pilot testing, the final form of the SEI was administered to a group of 87 eleven and twelve year olds. The scores ranged from 40 to 100 (100 being the maximum achievable score) with a mean of 82.3 and a standard deviation of 11.6. The instrument has fifty self-report items related to self-attitude, and eight questions used as an index of defensiveness. The sub-scale titles and their weights (number of questions) are, respectively, School-Academic (8), Home-Parents (8), Social Self- Peers (8), and General Self (26). A percentage score can be computed by multiplying the total raw score by two.

Coopersmith subsequently administered the SEI to 1748 students in the Connecticut school system. The mean for the males was 70.1 with a standard deviation of 13.8. The mean for the females was 72.2 with a standard deviation of 12.8, which was not significantly different from the male scores. The lower means recorded in this second study were attributed by Coopersmith to the more diverse ability, interest and social backgrounds of the members of the second group. In both studies the distribution of scores was skewed in the direction of high self-esteem. Test-retest reliability after a three-year interval with a sample of 56 children from the Connecticut population was .70.

Internal Consistency

A study by Kimball (1972) showed high internal consistency. Kimball had the SEI administered to 7600 Illinois public school students in grades four through eight. The sample was purported to be representative of the general population including black and Hispanic Americans. Kuder-Richardson reliability estimates were generated for each grade level. The coefficients obtained ranged from .87 to .92.

Construct Validity

Kimball in the same study found that "percentile equivalents showed a consistency of score values at a given percentile regardless of population." A study of SEI contruct validity reported by Kokenes (1974) compared the importance of home, peer, and school to the global self-esteem of pre-adolescents and adolescents. The sample was made up of 7600 students in grades four through eight. Her study "confirmed the construct validity of the subscales proposed by Coopersmith as measuring self-esteem."

Multidimensionality

Kokenes (1973) performed a factor analysis on the responses from the 7600 students used in her previous study. Four pairs of factors were found and each pair was congruent with the subscales of the SEI. Ketcham and Morse (1965) did a factor analysis on SEI scores of 484 students from a large inner city school system. The students were in grades 3, 5, 7, 9, and 11. The analysis isolated five factors: Social Self-Esteem, Doing Well in School, Self-Deprecation, and Self-Certainty.

The Behavioral Academic Self-Esteem Scale

The BASE was developed by Coopersmith and Gilbert (1981), based on the theories of Stanley Coopersmith and the work Coopersmith had done on an earlier scale called the Behavior Rating Form (BRF). The items on the BASE reflect items that emerge from factor analyses of the SEI and emphasize traits pertinent to students self-esteem as revealed in their academic performance. The five factors measured by the BASE are Student Initiative, Social

Attention, Success/Failure, Social Attraction, and Self-Confidence. The following are five sample questions, one from each of the five BASE factors and in the same order:

1. This child is willing to undertake new tasks.
2. This child cooperates with other children.
3. This child deals with mistakes or failures easily and comfortably.
4. This child's company is sought by his peers.
5. This child readily expresses opinions.

The BASE has a total of 16 questions using a five point rating scale from "never" to "always". The BASE total score reflects a student's overall level of academic self-esteem as based on a teacher's or other observer's judgements of the student's school behavior.

Data for the BASE was collected between 1974 and 1978 in the San Francisco Bay area. The sample was made up of over 4000 students from homes ranging in SES from lower to upper-middle. Correlations of individual items with the total score point up a high internal consistency, as every correlation was significant at the .001 level and ranged from a low of .37 to a high of .76 with a mean $\underline{z}$ transformation of the correlation coefficients of .61. Reliability between teacher ratings was an average of .71 as measured on several classes of students (N = 142).

Construct Validity

Construct validity of the BASE was supported by the general consistency of findings of a series of factor analyses. The BASE items factored consistently into five components in the following descending order of power: Student Initiative, Social Attention, Success/Failure, Social Attraction, and Self-Confidence. The strongest factor was Student-Initiative which accounted for 34.4, 45.7, and 59.7 percent of the total variance in each of three respective samples.

BASE total score norms are reported as follows: a mean of 55.2 out of a 100 for males with a standard deviation of 10.69, and a mean of 57.65 for females with a standard deviation of 10.18. A set of low, moderate, and high self-esteem ranges were arbitrarily constructed by defining the moderate range as being plus and minus one standard deviation from the mean. The resulting ranges for males are as follows: low 16-44, moderate 45-66, and high 67-80. The resulting ranges for females are as follows: low 16-47, moderate 48-68, and high 69-80.

Intellectual Achievement Responsibility Scale

The IAR is composed of 34 forced-choice items measuring locus of control. The higher one's score on the IAR the higher one's internal locus of control. The 34 items are broken into two sets of 17 items. One set measures internality as taking responsibility for one's successes (I+). The other set measures internality as taking responsibility for one's failures (I-). Combining the two sets gives a total score for internality. The first four questions on the IAR are as follows:

1. If a teacher passes you to the next grade, would it probably be

   ___a. because she liked you, or

   I+___b. because of the work you did?

2. When you do well on a test in school, is it more likely to be

   I+___a. because you studied for it, or

   ___b. because the test was especially easy?

3. When you have trouble understanding something at school, is it usually

   ___a. because the teacher didn't explain it clearly, or

   I-___b. because you didn't listen carefully?

4. When you read a story and can't remember much of it, is it usually

   ___a. because the story wasn't well written, or

   I-___b. because you weren't interested in the story?

Test-Retest Reliability

The original sample that Crandall used was composed of 932 elementary and high-school students drawn from five schools from diverse communities. Crandall reported that a sample of 70 ninth-grade students from one of the original test sites were retested after an interval of two months. The reliability coefficients were .65 for the total I,

.47 for the I+ subscale, and .69 for the I- subscale. These correlations were all significant at the .001 level.

Internal Consistency

Split-half reliabilities were computed separately for the two subscales. A random sample of 130 tenth and twelfth graders produced a correlation of .60 for both subscales. A correlation between subscales of .43 was found using a sample of 183 tenth graders which was significant at the .001 level.

Norms

IAR total scores at the tenth grade level were: a mean of 25.27 with a standard deviation of 4.62 and an ($N = 90$) for males; and a mean of 26.50 with a standard deviation of 3.93 and an ($N = 93$) for females.

Independent Variable

The independent variable was a four week computer programming experience (CPE) designed by the Atari Corporation. The CPE introduced computer graphics during the first week, computer sound generation during the second week, and computer text-processing during the third week. During the fourth week the students were encouraged to combine the graphics, sound, and text-processing modes into a unified project of their choice. Each segment was presented in a general form that gave the student maximum control over what happened with a minimum of computer code. The students had to learn appropriate computer code if they wished to continue. For example, one of the first graphics lessons presented a landscape on the screen. The students could add a river to the landscape with a minimum of computer code. However, if they wished to continue to add other items they had to learn Cartessian coordinates to tell the computer where to place them on the screen. They also had the option of choosing the color of the objects, but had to learn the appropriate code. Finally, they had to learn how to design their own shapes by using either Cartessian coordinate geometry or Turtle geometry. Gradually the students learned how to create the shape, size, color and position of the objects they wished to place in the landscape. By the end of approximately the second day of each segment most students had adequate skills to choose an independent project.

Procedure

The treatment took place at the Capital Children's Museum, in the Future Center which is equipped with Atari 800 microcomputers, color monitors, disc-drives, and printers. The instructors were museum staff who had three days of briefing by one of Atari's design team. The senior instructor had a week of training at the Atari headquarters in California. The instructors did not teach but were on call if a student wanted help. Most new material was presented from information on computer instruction discs, but some concepts were initially presented to the group as a whole.

The students reported each day at noon. They worked on the computers for two hours and then broke for an hour returning to programming from three until five. From five until six they were given the choice of either continuing their projects or exploring the numerous software programs that Atari had supplied. Three days a week, during the break, the students were led in controlled exercises that considered the uses of computers in modern society, and the ethical issues that surround their use.

Data Collection and Analysis

The two self-report instruments, the SEI and the IAR, were administered in the auditorium of Capital Children's Museum on the morning of the initial day of the CPE treatment and then again on the last day of the CPE treatment. The same two instruments were readministered eight months into the school year. However, this time they were administered to a comparison group in addition to the experimental group.

The self-report instruments were given in written form and the students were instructed as follows:

> Today you will be filling out two short questionnaires. Your answers will help me know your likes and dislikes

> better. Please pick the answer which best describes what happens to you or how you feel.

At no time was self-esteem, self-concept, locus of control, or responsibility mentioned, nor were these terms or any similar terms printed anywhere on the instruments. The SEI and IAR, together, took about a half hour to complete. For data to be admissible the student had to complete all of the questions on both instruments for each observation.

The BASE was rated by an instructors who had worked with the students. The instructors were well qualified to rate each student because of their close association with them for over 120 hours in an intensive learning situation. A possible problem might arise due to inter-rater reliablity because of either a halo effect, leniency, or error of central tendency.

The data for Hypotheses 1 and 3, that treat the differences between locus of control scores, came from the administration of Crandall's IAR to the experimental group on three seperate occasions.

The data for Hypotheses 2 and 4, that treat the differences between self-esteem scores on three separate observations for the experimental group, came from the administration of Coopersmith's SEI to the experimental group on three seperate occasions.

The data for Hypothesis 5, that treats the differences on locus of control and self-esteem scores between the experimental group and the comparison group, came from the third administration of both the SEI and the IAR.

The data for Hypothesis 6, that looks at differences in two of the subscales of the IAR before and after the treatment, came from the first and second administrations of the IAR.

The data for Hypothesis 7, that looks for a correlation between the self-esteem scores as derived by self-report and observation, came from the post treatment administration of the SEI and the completion of the BASE by the instructors at about the same time.

Product-moment correlations were used for measures of association, and *t* tests were used for measures of difference. One-tailed tests of significance were used to determine all *p* values, except on hypotheses three and four.

Ethical Considerations

There was nothing in the treatment or the testing that should have caused any subjects undue mental or emotional stress, embarrassment, or physical harm. All of the test scores were kept confidential. Permission to test the subjects was given to the Capital Children's Museum by their parents, which covered the first two testings.

Permission for the third testing was covered by Banneker Junior High School's right to test. Approval for this research was recieved from The American University's Institutional Review Board.

CHAPTER IV

RESULTS AND DISCUSSION

The purpose of this study was to investigate whether an intensive computer programming experience (CPE) would enhance the self-esteem and locus of control of a group of ninth and tenth grade students and whether any improvement would hold up over an eight month period. The independent variable was the CPE which had been designed by the Atari Corporation for use in their nation-wide summer computer camps. The CPE was held in the Future Center of the Capital Children's Museum six hours a day for one month during the summer. The dependent variables were locus of control and self-esteem and were measured on three separate occasions, before and after the treatment and again eight months later. A comparison group was constructed from classmates of the treatment group for the final administration of the self-esteem and locus of control instruments. Coopersmith's Self-Esteem Inventory was used to measure self-esteem, and Crandall, Katkovsky, and Crandall's Intellectual Achievement Responsibility questionnaire was used to measure locus of control. This chapter will first report and then discuss the findings of the research.

Results

Hypothesis 1

The mean score on locus of control for the treatment group will be significantly higher on the second observation than on the first.

Finding: The mean difference for locus of control between the pretest and postest was as predicted. The postreatment scores were significantly higher than the pretreatment scores, *t* (20) = 3.59, *p* = .001.

TABLE 1

MEAN DIFFERENCES FOR THE TREATMENT GROUP BETWEEN PRETEST AND POSTEST ON LOCUS OF CONTROL

IAR	*n*	*M*	*SD*	*df*	*t*	*p*
PRETEST	21	25.33	3.23	20	3.59	.001
POSTEST		27.33	2.97			

Note. All probabilities are one-tailed unless noted.

Hypothesis 2

The mean score on self-esteem for the treatment group will be significantly higher on the second observation than on the first.

Finding: The self-esteem scores acted as predicted. The postest means were significantly higher than the pretest means, *t* (20) = 3.52, *p* = .001.

TABLE 2

MEAN DIFFERENCES FOR THE TREATMENT GROUP BETWEEN PRETEST AND POSTEST ON SELF-ESTEEM

SEI	*n*	*M*	*SD*	*df*	*t*	*p*
PRETEST	21	80.33	12.62	20	3.52	.001
POSTEST		85.71	12.25			

Hypothesis 3

The mean score on locus of control for the treatment group will show no difference between the second and third observations.

Finding: Locus of control showed a non-significant gain between the postest and the follow-up eight months later, t (16) = .97, p = .347, (see Table 3). However, when the difference between means was computed for locus of control between the pretest and the eight month follow-up the difference remained significant, t (16) = 3.57, p = .002, (see Table 4).

TABLE 3

MEAN DIFFERENCES FOR THE TREATMENT GROUP BETWEEN POSTEST AND FOLLOW-UP ON LOCUS OF CONTROL USING A TWO-TAILED TEST OF SIGNIFICANCE

IAR	n	M	SD	df	t	p
POSTEST	17	27.53	2.67	16	.97	.347
FOLLOW-UP		28.12	2.93			

TABLE 4

MEAN DIFFERENCES FOR THE TREATMENT GROUP BETWEEN PRETEST AND FOLLOW-UP ON LOCUS OF CONTROL

IAR	*n*	*M*	*SD*	*df*	*t*	*p*
PRETEST	17	25.59	2.98	16	3.57	.002
FOLLOW-UP		28.12	2.93			

Hypothesis 4

The mean score on self-esteem for the treatment group would show no difference between the second and third observations.

Finding: The self-esteem mean regressed slightly between the postest and the follow-up, *t* (16) = - .78, *p* = .446 , (see Table 5). However, even with this regression on the eight month follow-up, there was still a significant residual improvement in self-esteem between the pretest and the follow-up, *t* (16) = 1.87, *p* = .041, (see Table 6).

TABLE 5

MEAN DIFFERENCES FOR THE TREATMENT GROUP BETWEEN POSTEST AND FOLLOW-UP ON SELF-ESTEEM USING A TWO-TAILED TEST OF SIGNIFICANCE

SEI

	n	*M*	*SD*	*df*	*t*	*p*
POSTEST	17	85.65	13.35	16	- .78	.446
FOLLOW-UP		83.53	10.55			

TABLE 6

MEAN DIFFERENCES FOR THE TREATMENT GROUP BETWEEN PRETEST AND FOLLOW-UP ON SELF-ESTEEM

SEI

	n	*M*	*SD*	*df*	*t*	*p*
PRETEST	17	79.94	12.47	16	1.87	.041
FOLLOW-UP		83.53	10.55			

Hypothesis 5

On the third observation the mean scores for locus of control and self-esteem will be higher for the treatment group than for the comparison group.

Finding: This hypothesis was not supported. Although the treatment group had higher mean scores than the comparison group on locus of control and self-esteem the mean differences were not significant at the $p < .05$ level, (see Tables 7 & 8).

TABLE 7

MEAN DIFFERENCES BETWEEN TREATMENT AND COMPARISON GROUPS ON THE FINAL OBSERVATION FOR LOCUS OF CONTROL

GROUP	n	M	SD	df	t	p
TREATMENT	17	28.12	3.15	31	.35	.365
COMPARISON	16	27.75	2.93			

TABLE 8

MEAN DIFFERENCES BETWEEN TREATMENT AND COMPARISON GROUP ON THE FINAL OBSERVATION FOR SELF-ESTEEM

GROUP	*n*	*M*	*SD*	*df*	*t*	*p*
TREATMENT	17	83.53	10.59	31	1.14	.131
COMPARISON	16	78.13	16.27			

Hypothesis 6

There will be a greater improvement in mean (I-) scores than in the mean (I+) scores between the first and second observations of the treatment group.

Findings: Both the I+ scores and the I- scores improved significantly between the pretest and the postest, I+: *t* (20) = 2.20, *p* = .020 and I-: *t* (20) = 2.71, *p* = .007. The I- scores improved substantially more than the I+ scores as can be seen by the higher *t* and *p* values. This finding is of practical significance because traditionally Black students have scored lower on the I- subscale which measures the degree to which one takes responsibility for one's failures.

Hypothesis 7

There will be a significant correlation between self-esteem recorded by self-report and that recorded by instructors.

Findings: This hypothesis was not upheld. The correlation between the SEI (self-report) and BASE (behavioral observation) scores was, $r = .292$, $p = .099$.

All data was analyzed using the Statistical Package for the Social Sciences, version H, release 9.1, (see Nie et al., 1975).

Discussion

Locus of Control

The changes in total locus of control as measured by the IAR before and after the CPE treatment and again eight months later were largely as anticipated. There was a significant increase in means between the pretest and postest, for the treatment group, $t(20) = 3.59$, $p = .001$, (see Table 1), and this improvement held up and actually made a slight additional increase over the eight month follow-up period (see Table 4).

The treatment group was made up of 21 ninth and tenth graders all of whom were of black racial origin. Historically, the IAR has shown less sensitivity to differences due to race than have other locus of control instruments. Solomon, Houlihan, & Parelius (1969) found no race differences in response to the IAR. They attributed this to black students feeling more in control of academic settings than more general social settings. Crandall (1965) drew attention to this aspect of the IAR stating that it was designed to assess children's belief in reinforcement responsibility in intellectual-academic achievement situations and not to assess reinforcement responsibility in multiple behavioral areas. The IAR data for Total I's found in this study is similar to the normative data reported by Crandall et al. (1965). Tables nine and ten illustrate this.

TABLE 9

PRETEST SCORES ON LOCUS OF CONTROL

FOR THE TREATMENT GROUP FROM THE PRESENT STUDY BY SEX

Subjects	Total I			I+		I-	
	n	*M*	*SD*	*M*	*SD*	*M*	*SD*
Boys	8	25.13	2.03	14.50	1.69	10.63	1.41
Girls	13	25.46	3.87	14.38	2.14	11.08	2.59
Total	21	25.33	3.23	14.43	1.94	10.91	2.19

TABLE 10

LOCUS OF CONTROL (IAR) 1965 NORMATIVE DATA FOR A TENTH GRADE SAMPLE BY SEX WITH I+ AND I- MEANS

Subjects	Total I			I+		I-	
	n	*M*	*SD*	*M*	*SD*	*M*	*SD*
Boys	90	25.27	4.62	13.13	2.60	12.13	2.83
Girls	93	26.50	3.93	13.29	2.22	13.22	2.40
Total	183	25.90	4.33	13.21	2.41	12.68	2.68

The sample for the normative study was drawn from a population with a fairly normal SES distribution. However, it was not heavily weighted with families on the lower end of the distribution, and it had no subjects from large metropolitan areas. In contrast, the subjects in this study were all from a large metropolitan area and were predominately from families of lower to middle SES background. Taking these two differences into consideration it would appear that the subjects of the present study were testing higher for locus of control than might have been expected. A partial explanation for their scores might reflect a selection factor as all the subjects were enrolled in a competative academic junior high school at the time of the treatment.

Intercorrelations between the pretest and postest were, $r = .67$, $p = .001$ for the Total I's; $r = .65$, $p = .001$, for the I+ scores; and $r = .57$, $p = .003$ for the I- scores. In the light of the high intercorrelations between the pretest and postest and the relatively high initial IAR scores the subsequent improvement in locus of control suggests that a CPE can have a practical use in enhancing locus of control.

Hypothesis six looked for more improvement in the I- than the I+ subscale scores. I+ scores represent taking responsibility for one's successes, whereas the I- scores represent taking responsibility for one's failures. Hypothesis six was based on the premise that the intensive debugging necessary in the CPE program would have a particularly positive effect on the subject's I- scores. Both the I+ scores and the I- scores improved significantly between the pretest and the postest, I+: t (20) = 2.20, $p = .020$ and I-: t (20) = 2.71, $p = .007$. The I- scores improved substantially more than the I+ scores as can be seen by the higher t and p values. This finding could be of practical significance, because traditionally Black students have scored lower on the I- subscale. No significant difference was found between male and female means on either the I+, I-, or Total I scores, except on the postest I- scores where the female mean was significantly higher, t (13) = 2.65, p = .019.

An interesting similarity between this study and another locus of control study shows up in the I- scores. DuCette et al. (1972) reported that the black children in his study tested higher on internal control of success than failure, whereas the white children tested more internal on control of failure than success.

Self-Esteem

The difference between the pretest and postest means for self-esteem, as measured by Coopersmith's SEI, showed a significant increase,for the treatment group, t (20) =3.52, p = .001. Between the postest and the follow-up there was a decline in the self-esteem scores. However, there still remained a significant increase for self-esteem between the pretest and the follow-up at the $p < .05$ level.

The subjects tested high for self-esteem on the pretest which raised some concern over a possible ceiling effect. Coopersmith (1967) reported scores for the SEI based on a sample of 1748 central Connecticut public school children from diverse social backgrounds. Strodtbeck (1972) administered the SEI to 321 subjects aged fourteen to seventeen from Chicago and Washington, D.C., most of whom were Black and all of whom were from low income families.

Table eleven summarizes Coopersmith's (1967) data, Strodtbeck's (1972) data, and the self-esteem data from this study.

TABLE 11

SELF-ESTEEM DATA FROM COOPERSMITH'S (1967) STUDY, STRODTBECK'S (1972) STUDY, AND PRETEST DATA FROM THE PRESENT STUDY BY SEX

	Coopersmith		Strodtbeck	Present	
SEI					
	M	*SD*	*M*	*M*	*SD*
MALE	70.1	13.8	73.6	81.0	10.6
FEMALE	72.2	12.8	76.2	79.9	14.1
	N = 1743		N = 321	N = 21	

Coopersmith reported a test-retest reliability of .70 after three years with a sample of 56 from the original population. A correlation of $r = .84$, $p < .001$ was computed between the pre and postests of this study. No significant difference was found between the male and female means on either of the three observations for self-esteem.

The correlation between the SEI self-report scores and the BASE behavioral report scores was not significant as postulated in hypothesis seven, $r = .292$, $p = .099$. The correlation was most probably affected by inter-rater reliability. The subjects were rated by four instructors, two of whom rated all fours and fives on a five point Likert type scale, while the other two rated close to the mid-range. A better procedure would have been to use a single rater.

Hypothesis five looked for a significant difference in locus of control and self-esteem between the treatment and comparison groups. No significant differences were found. This finding points up three shortcomings in the research design. First, the subjects for the treatment and comparison groups were not randomly selected, which limits the gereralizability of the study. The treatment group was chosen to participate in the Atari sponsored CPE because they had no prior computer experience. The members of the comparison group, on the other hand, all had in-school computer experience at least by the time of the follow-up testing. Therefore, in order to make valid comparisons between the treatment and comparison groups, pre-computer experience data on the comparison group would also be needed. Second, no valid control group could be found during the summer. A control group with no computer experience either before or during the life of the study would have strengthened the internal validity by helping to control for maturation, Hawthorne, and halo effects. Third, by the time the treatment and comparison groups were tested, some members of each group had had additional computer experience which could partially confound interpretation of effects attributed to the CPE. Even taking the limitations of the study into consideration, something significant did happen to the treatment group. Their self-esteem and locus of control both made statistically significant changes that held up over time.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

With the advent of microcomputers in the schools an increasing number of students are learning to program computers, but little is known about the effects of computer programming on non-cognitive factors such as self-esteem and locus of control. Many studies (Davis, 1980; Morgan, 1974; Stake, 1978; Suppes & Morningstar, 1972) have researched the effects of computer-based instruction on school achievement. Other studies (Crandall, 1975, 1977; Smith, 1971; Warner, 1979) have looked at the effects of computer-based instruction on both cognitive and non-cognitive factors. However, the writer knew of no previous experimental or quasi-experimental study that looked at the effects of computer programming on student's self-esteem and locus of control.

Anecdotal descriptions of attitudinal and self-image changes due to working with computers have been reported in the popular and case study literature for a number of years. LOGO, a computer programming language designed for use by children was extensively tested by Seymour Papert and others at MIT, Papert et al. (1979). In their evaluation of LOGO they made many references to observing positive affective changes. Crandall (1977), made similar observations in his study of lower SES Hispanic children in the Los Angeles area. These studies led the writer to try to measure experimentally the affective changes which were being reported behaviorally.

Locus of control and self-esteem were chosen as the dependent variables, and an Atari-designed computer programming experience as the independent variable. The treatment group was a sample from a lower to middle SES population made up of 21 ninth and tenth graders all of black racial origin. The treatment, the Atari sponsored CPE, was offered specifically to students from the schools of the District of Columbia and was held during the summer of 1982 at the Capital Children's Museum.

The study was based primarily on the following concepts and literature: a) locus of control, (Crandall et al. 1965; deCharms, 1968; and Rotter, 1966); b) self-esteem, (Coopersmith, 1967; Covington and Beery, 1976; and Purkey, 1970); c) intrinsic motivation, (Lepper and Greene, 1975; and Malone, 1980); d) student-computer interaction, (Moore and Anderson, 1969; and Papert, 1981).

Locus of control was measured by the Crandall's Intellectual Achievement Responsibility questionnaire, which measures the level at which a person is taking responsibility for his or her academic successes and failures. Locus of control has been correlated with school achievement by many studies, (Bar-Tal & Bar-Zohar, 1977; Coleman et al., 1966; Messer, 1972).

Self-esteem was measured by Coopersmith's Self-Esteem Inventory which was chosen over other self-esteem scales because it had been designed for use with school-age children. Both self-esteem and locus of control resist long term change although they will show short-term shifts. An eight month follow-up was built into the study to try to control for short-term shifts.

The literature on intrinsic motivation suggests why many students become deeply involved when programming a computer. The student is his own agent. He is task or information oriented and is gaining rewards for his exploration or mastery of the programming task at hand. The rewards are intrinsic, and not dependent on a significant other person. The student is encouraged to find his own solution to problems within the range of his capabilities. Reciprocity with a teacher can develop but not at the expense of the autonomy of either party. Computer programming satisfies many of these factors and has the potential for developing self-worth because the student is less dependent on external praise or rejection.

Student-computer interaction: Papert (1981) talks of safe, stimulating interactive learning environments where a student can explore and be served by direct experience. He calls them "microworlds". The sense of freedom the student feels when exploring in an appropriate microworld enhances the process of self-correction through feedback from the machine. Moore and Anderson (1969) define the responsive conditions of such an environment as follows.

> 1. It permits the learner to explore freely, thus giving him the chance to discover a problem.
>
> 2. It informs the learner immediately about the consequences of his actions.
>
> 3. It is self-pacing.
>
> 4. It permits the learner to make full use of his capacity for discovering relations of various kinds.
>
> 5. It is so structured that the learner is likely to make a series of interconnected discoveries about the physical, cultural or social world. (p. 602)

Such an environment allows the student to be independent and to have a sense of mastery over the techniques necessary to control it. In actuality the student is not in control of the machine itself. Complex operating systems and compilers drive the system but the student has the illusion of being in control.

This study used a non-equivalent comparison group design with repeated measures on the treatment group, and with comparison to a non-equivalent reference group on the final or follow-up observation. The self-esteem and locus of control instruments were given three times to the treatment group, before and after the computer programming experience. The same instruments were given again eight months later to the treatment group and a comparison group.

Self-esteem mean scores increased significantly between the pretest and postest and regressed slightly on the follow-up test given eight months later. However, the difference in the means between the pretest and the follow-up remained significant.

Locus of control mean scores increased significantly between the pretest and postest, and made a non-significant gain between the postest and the follow-up. The difference between mean scores between the pretest and the follow-up for locus of control was significant. For both self-esteem and locus of control no significant difference was found between the treatment and comparison group. All hypotheses were tested at a $p < .05$ level of significance unless otherwise noted.

Conclusions

This study was about the enhancement of self-esteem and locus of control due to computer programming. Even with its limited generalizability beyond the present sample it does suggest that an appropriate computer programming experience can effect a positive shift in locus of control and self-esteem. The fact that locus of control and self-esteem both improved significantly raises the question of how the treatment might have brought about the change. From observing the students going through the CPE program the following things were noted:

The students did seem to develop a sense of being agents of their own learning. They eagerly experimented with new computer code and procedures in order to carry out projects of their own design.

The students did seem to develop a reciprocal perspective, learning how others viewed them. They were continually comparing their problems and their solutions.

The students used the staff as referees and as resources. An example of this was when some of the students wanted to program a favorite song into the computer. They understood the pitch notation that the computer required, but they needed help getting from standard sheet-music notation to the pitch notation.

The students exhibited the autotelic principle as they seemed to have little fear of the computer and explored freely in the graphics, sound and text environments of the CPE. They seemed to have little fear of making mistakes and learned to use feedback from the machine in a constructive manner.

The students did seem to develop a better sense of themselves as learners. One of the most significant aids toward reflexive improvement were the computer discs that each student had. Everything the student programmed could be saved on his or her disc. The student did not have to save everything. Nevertheless, here was a record of their learning process, from the first day, that they could review, add to, or delete from as they saw fit.

Recommendations

The Atari program was highly engaging and designed around sound educational principles. Similar programs would be of value in the schools not only for their affective benefits, but also for their cognitive benefits. The Capital Children's Museum was an enchanting environment in which to hold the CPE. Increased use of computer experiences by museums, summer camps, educational parks and other non-school learning centers should be encouraged. It would be hard to duplicate this intensive experience in the schools, but it could be done by spreading the experience over three or four months. It would be interesting to know if the difference in time of delivery would change the results.

A study similar to this one should be done using different age groups, and different SES samples, with more demographic and achievement data on the subjects. Other non-cognitive constructs should also be considered. In addition, randomly selected experimental and control groups would add confidence to the findings and to their generalizability.

The treatment raises the following questions that should be considered for further research. Should a teacher be more of a coach or guide than a didactician when working with students in computer programming situations? How many students using a computer at the same time is optimal? How can various types of knowledge bases be embedded into programming experiences and to what ages are they appropriate?

Based on this study, educators might consider computer programming as a viable method for enhancing student's self-esteem and locus of control. If students can be made to think of themselves as success oriented individuals, able to define and solve problems, their mastery over learning situations should improve greatly. To expect such a change from even the most exemplary educational program is asking a lot. However, the findings of this study suggest that the use of innovative computer programming experiences to enhance self-esteem and locus of control might be a rich area for further exploration.

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